welcome to the
European Microkelvin Collaboration

CAPACITIES

Application Form for MICROKELVIN Transnational Access Project

1. General Information

Project number:	**CNRS 19**	
Project Title:	**Specific heat measurements of disordered films across the superconductor-insulator-transition**	
Lead scientist:[1]	**Title:**	Prof.
	First name:	Aviad
	Last name:	Frydman
	Home institution:	Bar-Ilan University, Ramat Gan, Israel
Host scientist:[2]	**Title:**	Senior researcher
	First name:	Olivier
	Last name:	Bourgeois
	Home institution:	Institut Néel, CNRS - Grenoble
Project scientist:[3]	**Title:**	Mr.
	First name:	Shachaf
	Last name:	Poran
	Birth date:	Nov. 20th, 1984
	Passport number:	11844240
	Research status/Position:	Ph.D student
	New User:[4]	Yes
	Scientific Field:	Condensed matter
	Home institution:	Bar-Ilan University
	Is your home institution MICROKELVIN partner?	No
	Business address:	Bar-Ilan University
	Street:	
	PO Box:	
	City:	Ramat Gan
	Zip/Postal Code:	52900
	Country:	Israel
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	E-mail:	Scf1984@gmail.com
	Curriculum vitae (18 lines max): - 2010-current – Ph.D. of Physics student at Bar-Ilan University, in the field of disordered superconductors and vortex dynamics. - 2008-2010 – M.Sc. of Physics at Bar-Ilan University, in the field of disordered superconductors.	

1 The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.
2 The host scientist is supervising the work of the visiting project scientist at the infrastructure.
3 The project scientist is the person who will be visiting the infrastructure.
4 Indicate 'Yes' only if the user has never visited the infrastructure before this specific project, otherwise write 'No'.

	- 2005-2008 – B.Sc. in Physics and computer science at Bar-Ilan University Practical experience and skills: • Cryogenic measurements • Transport and Magneto-transport measurements (AC and DC) • Scanning force microscopy imaging (AFM, MFM etc.) • Electron beam microscopy (SEM) • e-gun and thermal Thin layer deposition • Quench condensation • photo-lithography and e-beam lithography Fields of Expertise: • Superconductor-Insulator transition (SIT) in 1- and 2- dimensional systems • Mesoscopic sample fabrication and characterization • Anderson and Mott insulators • Tunnel junctions
	Five most recent publications:
	PRB **85** 054512 (2012) - B. Rosenstein, I. Shapiro, B. Ya. Shapiro, Dingping Li, A. Frydman, S. Poran, and D. Berco - Extended object tunneling: Current-carrying states of Abrikosov vortices in a superconductor with artificial nanobarriers
	PRB **84**, 014529 (2011) - S. Poran, E. Shimshoni, and A. Frydman - Disorder-induced superconducting ratchet effect in nanowires

Other participating scientists:[5]	**Name:**	**Position:**	**New User:**[2]
	1-Aviad Frydman	Prof.	no

2. Project Information

Name of host infrastructure:	**Institut Néel**			
Access provider / Infrastructure Director:	**Name: Olivier Bourgeois/ Henri Godfrin**		**E-mail address: henri.godfrin@grenoble.cnrs.fr**	
Planned project dates:	**Start date:**	**01/06/2013**	**Completion date:**	**31/08/2013**

Project description (12 lines max):

The interplay between disorder and superconductivity has intrigued physicists for decades. Experimentally it was found that superconductivity in 2D thin films can be destroyed by a sufficiently large degree of disorder. Once superconductivity is destroyed the sample undergoes a transition to an insulating state across a superconductor insulator transition (SIT), a fundamental manifestation of a quantum phase transition at T=0. Recently this field was revived due to the experimental observations of a number of dramatic features near the SIT such as simple activated temperature dependence of the resistance on the insulating phase, a large peak in the magneto-resistance and traces of superconductivity at temperatures above Tc and in the insulating phase. Current experiments, focused on transport and tunneling methods, seem to have reached saturation and new techniques are needed in order to shed light on the physics behind the superconducting transition in disordered films. In this respect, thermodynamic heat capacity measurements may provide important information towards solving some of the puzzles of the field.

Scientific objectives of the project (12 lines max):

We plan to study the heat capacity as a function of temperature of different disordered superconductors undergoing the SIT. The first system is ultrathin lead films. These films can be produced by quench conden-

[5] Please list all participating user group members. Expand the table, if necessary.

sation at low temperature directly in the calorimeter. As the number of atomic layers increases, the Pb films encounter an insulator to superconducting transition. Depending on the substrate we can produce and study either granular or uniform Pb films.

A different system is amorphous Indium oxide samples which can be driven through the SIT by means of low temperature (80^o C) annealing which varies the disorder. We plan to study the SIT by means of Cp variation versus temperature on both sides of the transition and focus on the shape of the Cp jump at the transition. This has never been done for highly disordered systems. The comparison between the different systems and geometries is expected to provide new insight into the processes that drive the SIT. One of the major objectives will be to search for Cp jumps on the insulating side or at temperatures above Tc determined by transport.

Technical description of work to be performed (20 lines max):

Ultra thin Pb films will be quench condensed in situ in the calorimeter directly on the membrane sensor. The collaborators will use the facilities of TA2, especially a specific experimental probe developed at the Institut NEEL as well as the nanofabrication facilities of NANOFAB. The thermal evaporation of lead and germanium in situ has to be fully characterized at low temperature. The calibration of the quartz crystal is crucial to control the thickness of the thin films very accurately. The highly sensitive Cp measurement has to be operational at very low temperature in order to follow the appearance of a peak versus temperature as the layer is grown in situ or as the disorder is changed by thermal annealing. The major advantage of this method is to be able to measure the Cp signature versus resistance of the thin film without being obliged to open the system. All the Cp measurement will be performed down to the lowest temperature of the cryostat.

A first characterization of the superconducting layer by regular resistive measurement is the first step. The second step will be the actual measurement of heat capacity. The overheating during the evaporation of the materials in the quench condensation has to be estimated and measured through the thermometer on the membrane. Detection of signs for superconductivity in the insulating phase or at temperatures smaller than 1K (down to 0.3K) will require very precise temperature control and monitoring.

3. Joint Proposals / Funding

Is this project in collaboration with other (concurrent) projects at the infrastructure?	**No**
If yes, please specify:	

Is this proposal submitted to any funding programmes?	**No**
If yes, please specify:	

The completed Application Form should be submitted to MICROKELVIN Management Office (**Katariina@neuro.hut.fi**, fax +358-9-47022969)